The influence of Cu doped on structure and mechanical properties of aluminium material

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Abstract. Development of technology in industrial field specially automotive needs specific materials with good properties. Aluminum materials are as alternative to answer this challenge. Aluminum alloy that is being developed by Cu doped will be found the new material with good properties. In this report, we have synthesized AlCu alloy using hot mixing method. The composition of 95.1 to 96.2 wt % of Al and 3.8 to 4.9 wt% of Cu were synthesized by melting and mixing process at a temperature of 1100 ^{o}C. Analysis of the structure of x-ray diffraction data for Al-Cu showed a single phase of Al for all compositions. The mechanical properties such as hardness of highest vickers of alloy of 96.2% Al - 3.8% Cu is 80 kg/mm^2 for cooling in room temperature.

1 Introduction

In the development aluminium alloys, various results have been published on the structure, mechanical properties [1–4] and their degradation at various conditions of the alloys [5–9]. Several methods of processing of aluminium alloys have been demonstrated by different authors [2,5,8,10–14]. Alloying addition have been reported to successfully enhanced the aluminium alloy properties such as corrosion resistant and mechanical properties [5,15,16]. The aluminium alloy containing Al-Mn and Al-Mg [5] alloys are the least resistant to corrosion under various conditions. In this paper we have investigated pure aluminium (Al) containing various copper (Cu). In order to enhance mechanical properties, the addition of 3.8 wt %, 4.4 wt % and 4.9 wt % of Cu have been prepared. The composition of Al-Cu alloys were synthesized by melting and mixing process at a temperature of 1100 ^{o}C. Structure analysis using x-ray diffraction (XRD) to show Al phase of all compositions and Scanning Electron Microscope (SEM)-EDAX for examination of microstructure. The hardness vickers method to evaluate mechanical properties of Al-Cu alloys.

2 Experimental procedure

In this work, aluminum (Al) and copper (Cu) are chosen to be combined through a melting process for the purpose of increasing mechanical properties. The starting materials include Al and Cu solids with a purity of more than 98% which are both melted at 1100 ° C. After the smelting of Al-Cu alloy is printed on metal sheet metal for quick cooling process. A Phillips X-ray diffraction system was used to obtain the X-ray diffraction pattern of the Al-Cu alloy. The microstructures of the samples were invested by scanning electron microscopy (JEOL JED-2300LV) equipped with energy dispersive X-ray analyses (EDAX) to determine the composition of contents at each sample position. Mechanical properties of Al-Cu alloys were evaluated by microhardness tested at the cross section of surface Al-Cu samples with a load of 200 g and duration of 5 s using a Vickers optic microhardness tester.

3 Results and discussion

Phase composition of Al-Cu alloys were examined by XRD, the result is shown in Fig. 1. It shows for all of composition 3.8 wt %, 4.4 wt % and 4.9 wt % of Cu that the main phases of aluminum (Al) and no second phase.

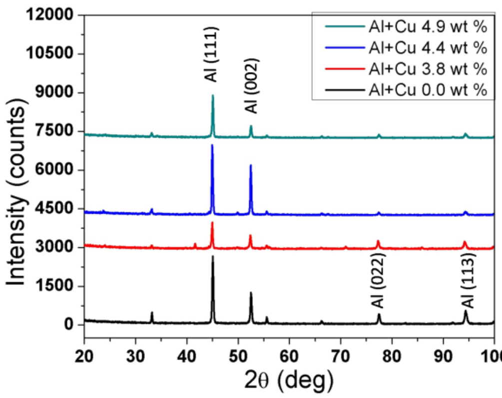

Fig. 1. XRD pattern of Al-Cu alloy with Cu 3.8 wt %, 4.4 wt % and 4.9 wt %.

This indicates that Cu has entered into Al structure to form Al-Cu alloy. However, when XRD diffraction

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patterns have been seen irregular changes in peak intensities in (111), (002), (022), and (113). Thus Al with the addition of Cu has altered the crystal structure.

According to SEM and EDAX analysis (shown in Fig 2), there are three areas: the gray areas (Fig.2c) showing the dominant amount, the black areas which are the grain boundary and the white areas attached to the grain boundary area. The results of EDAX analysis to Al-Cu 3.8 wt% alloy in three regions can be seen that Cu is white area in grain boundary in large amount (Fig 2b) and in gray area not found Cu while in black area Cu in small amount (Fig. 2a).

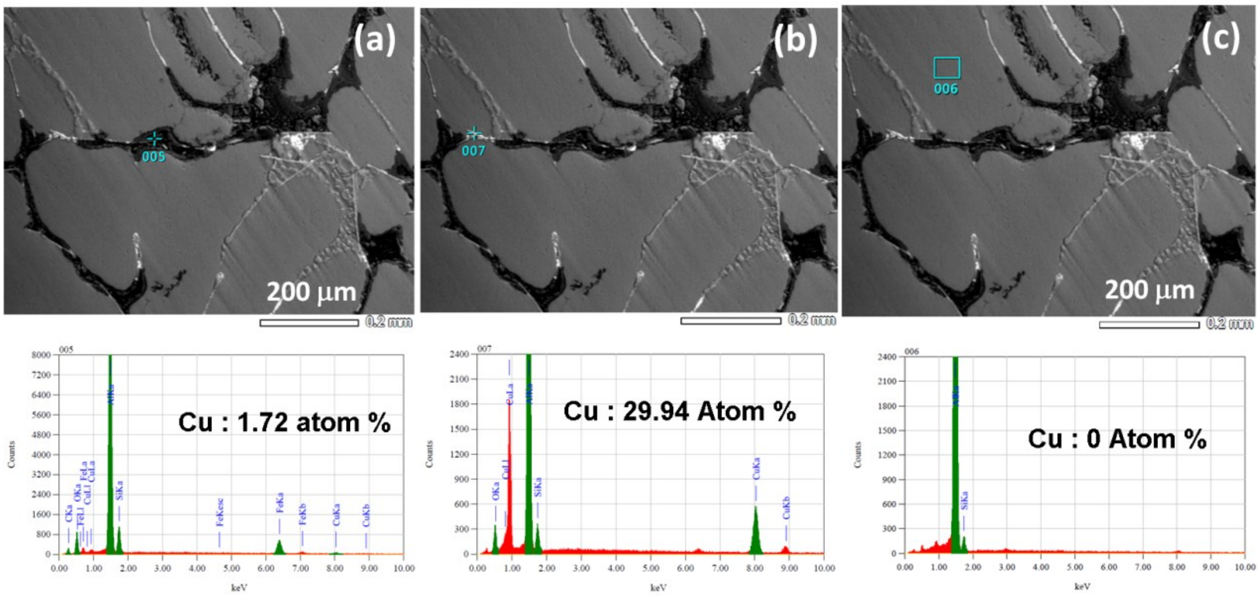

Fig. 2. SEM photograp and EDAX with different position analysis of Al-Cu ingot with Cu 3.8 wt%.

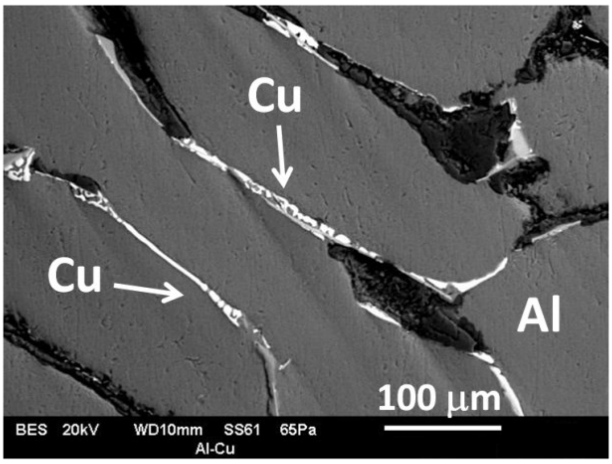

Fig. 3. SEM photograp of Al-Cu with Cu 3.8 wt %.

Figure 3 is the microstructure of Al-Cu alloy which melted at temperature 1100 ºC. It can be seen that the grains and grain boundary clearly observed. Al-Cu alloy has a large grain shape with size in length about more than 300 µm and width 100 µm. The grain shape is like a dendrite form which is the result of a rapid cooling process. White layer which coated the grain boundary of Al. The black area of the grain boundary is seen as an empty area with a small amount of Cu due to the large grain size of Al.

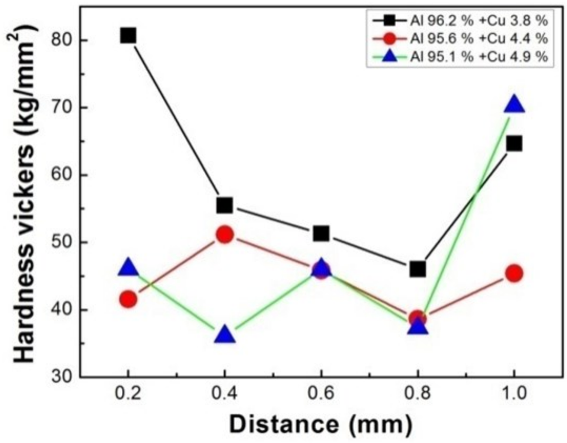

Fig. 4. The Vickers' microhardness of Al-Cu ingot with various Cu contents.

The Vickers' microhardness results are summarized in Fig. 4. Al-Cu alloy with Cu 3.8 wt % had the highest value at 80 kg/mm^2, and Al-Cu ingot with Cu 4.9 wt % had the lowest microhardness of 20 kg/mm^2. The microhardness decreased as the initial Cu contents increased. Both grain size and relative density (vacancies in garin boundaries) could affect the microhardness. In addition to the effect of Cu contents influences microhardness.

4 Conclusion

Al-Cu alloys have synthesized that were melting at at temperature 1100 °C. The effect of Cu on the microstructure and mechanical properties of Al-Cu alloys were investigated. Al-Cu alloy has a large grain shape with size in length about more than 300 μm and width 100 μm. Al-Cu alloy with Cu 3.8 wt % had the highest value at 80 kg/mm^2, and Al-Cu ingot with Cu 4.9 wt % had the lowest microhardness of 20 kg/mm^2. The microhardness decreased as the initial Cu contents increased.

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